

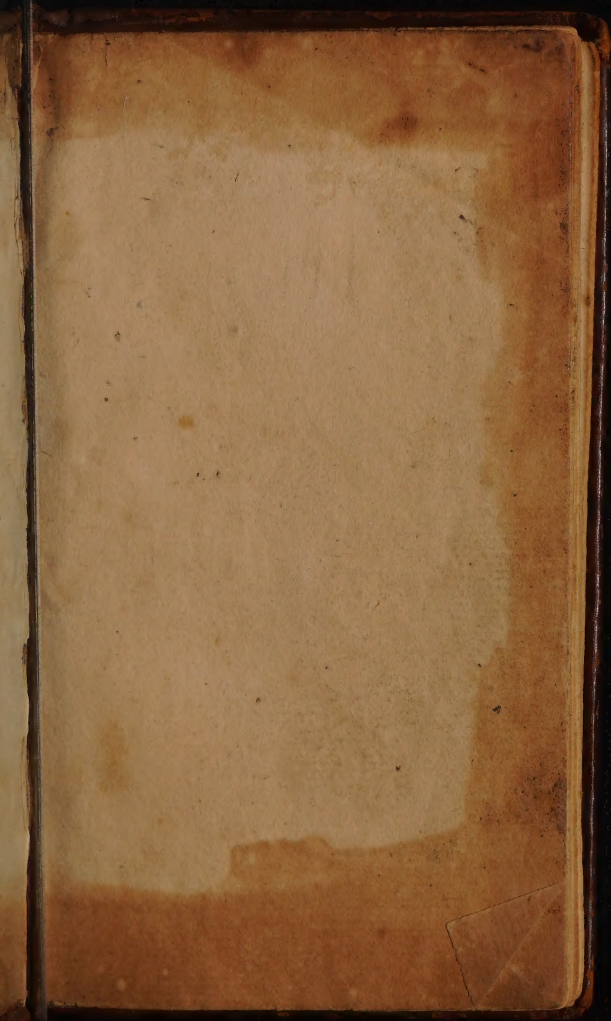


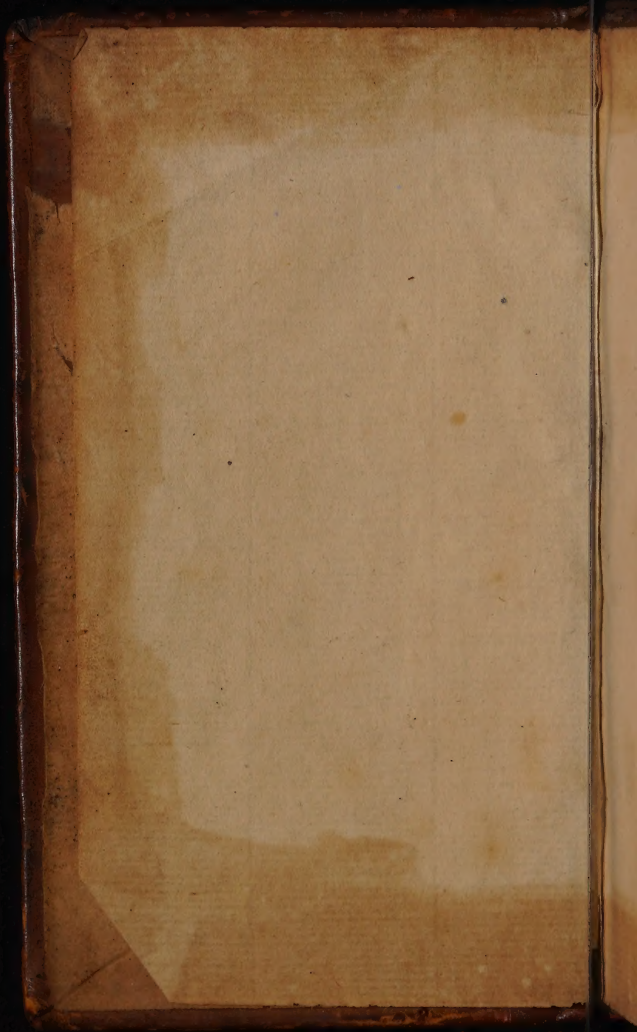


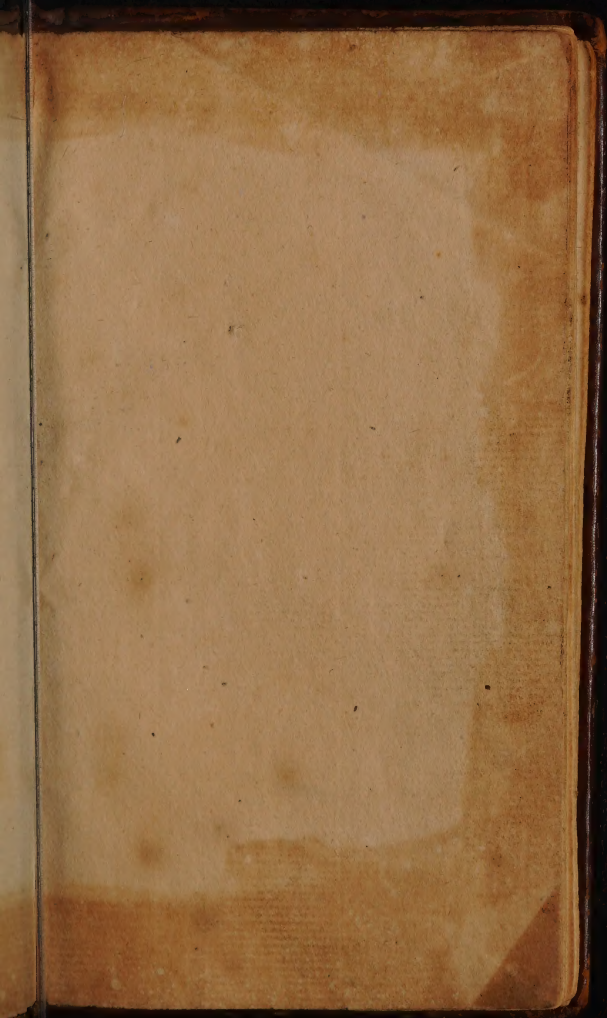


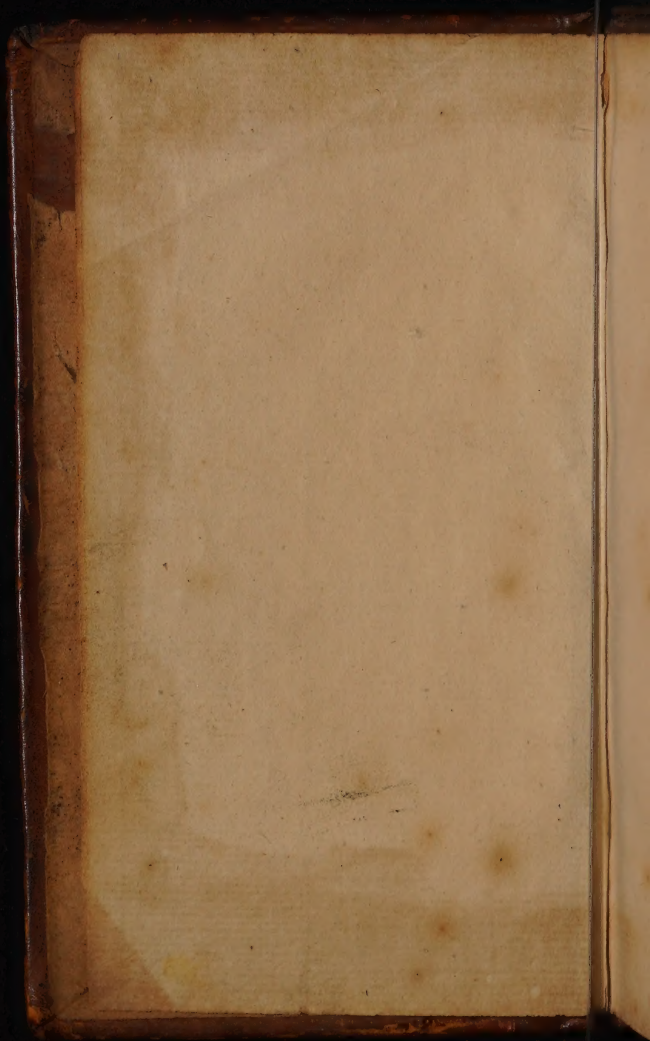


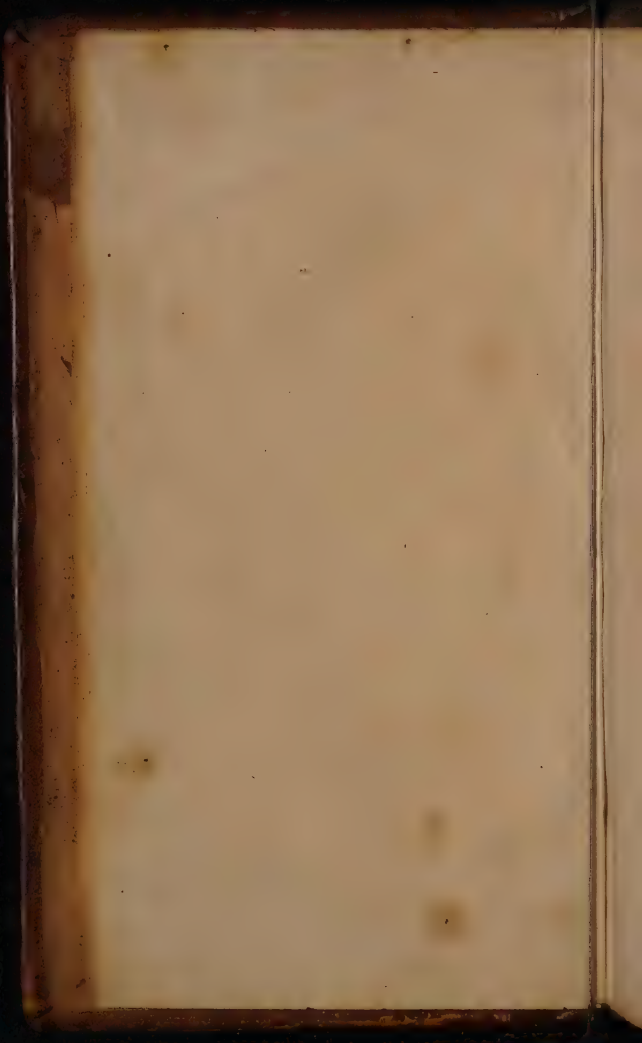
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TRactatum hunc cui Titulus
(*A Treatise of the Reason
of Muscular Motion, &c.*) dignum
Censemus, quî Imprimatur.

Samuel Collins, Præses.

Thomas Burwell, Sen.
Richard Torless,
William Dawes,
Thomas Gill, } Censor.

*Datum in Comitibus Censoriis
ex Ædibus Collegii nostri:
Sept. II. 1696.*

Tho: Green.

ac A 42
TREATISE
OF THE
REASON
OF

Muscular Motion :
Or the Efficient Causes of the
Contraction of a Muscle.

WHEREIN
Most of the *Phænomena* about
Muscular Motion are explained.

By RICHARD BOULTON, of the
City of Chester, *Medicini Proficiens.*

Τὰ ἀπαντα συμπνέν καὶ σπρρύν.

LONDON,

Printed by A. and J. Churchill, at the
Black Swan in *Pater-Noster Row*, 1697.

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TO THE
MOST LEARNED
AND
EVER HONOURED

Dr. Collins, President:

Dr. Thomas Burwell,
Dr. Richard Torlesse,
Dr. William Dawes,
Dr. Thomas Gill:

CENSORS

OF THE

Colledge of Physicians;

This Treatise is Humbly Dedicated

By Your Most Faithful

And Obedient Servant

R. BOULTON.

=

R

I

I am
it ap
sonab
ticula

TO THE
READER.

I Have examined this
Treatise with the
strictest Reason that
I am Master of ; and
it appears to me Reason-
able, in every Partic-
ular.

A 2 But

The Preface.

But I am altogether desirous of Truth, and would not out of any fond Opinion of my own Hypothesis, receive it sooner than another Man's. I am most inclined to suspect whatever is a Fætus of my own Brain.

If it may be any ways servicable to others, I have my Desire.

The

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THERE is now *Printing*
and will soon be *Published* by A. & J. Churchill,
Marcelli Malpighii Vita &
Opera Posthuma, fol. cum Figuris.

OF

(I)

OF THE
REASON

OF

Muscular Motion :

OR,

*The Efficient Causes of the Con-
traction of a Muscle, &c.*

IF we consider the Usefulness of Muscular Motion, with respect to an Individual ; and that, either as it tenderth

The Usefulness of Muscular Motion, as it tends to the maintenance of life.

B

to

to the maintenance of Life, or the perfection of Man, that is, with respect to the Soul, and the Animal Functions ; it is the very spring upon which all our Actions, both Natural, Vital and Animal wholly depend. By the Assistance of Muscular Motion, all the parts of our Body perform their particular Offices : Our Food is prepared by Mastication, and conveyed to the Stomach ; the concocted *Chymus* is thence expelled into the *Intestines*, where the purest *Chyle* is separated from the impurer *Fæces* ; every peculiar Liquor circulates through its distinct and proper Vessels : The *Chyle* through its *Lacteals*, and the *Lympha* through its Ducts ; and the Mass of Blood

is

is distributed through the Arteries, that all the Parts of the Body, both Principal and Sub-servient, Noble and Ignoble, may receive their proper Liquors : In a word, it is by this very Action of Muscular Motion, that τὰ δ' πάντα συμπνεῖν καὶ σπῆν.

If we respect the Animal Functions, they so much depend upon Muscular Motion,

*With respect
to the Soul and
its Functions.*

that when the Heart ceaseth to move, all the Faculties of the Soul are presently extinguish'd. The Faculties of the Soul are not only dependent on Involuntary, but also Voluntary Motion ; without which, both our Eyes and Ears would be unfit to receive ex-

ternal Objects; and Man would be endowed with a Sensitive and Rational Soul to no purpose. Our outward Senses would in vain receive external Objects, unless we had an Intelligent Faculty; in vain should we Understand, unless we had Reason to distinguish good from evil, that we might desire the one, and condemn the other: In vain also would be the Dictates of our Reason, if we had not a *Loco-Motive* Faculty, to pursue those things we desire, and to flee from those things which we are willing to avoid. But by Muscular Motion, the Dictates of our Reason, accordingly as they are byassed by our Appetites, are put into Action, and the intimate results
of

of all our Faculties are brought to light. Muscular Motion is the very *Index Animi*, by which the Temper and Disposition of the Animal Faculties are made evident ; it's the Ultimate Result of our most secret Thoughts and of our Will ; so that if we weigh but the mutual dependence of all the Parts of a Man's Body, there is no Reason, that a Muscle should be termed an Ignoble part ; since by the loss of a single one, either the Natural, Vital, or Animal Faculties are in some measure vitiated.

*A Muscle is a
Noble part.*

The Stomach, the Liver, the Spleen, the Lungs, &c. are all subordinate and subservient to the Principle Faculties of the
B 3 Soul ;

Soul; in as much as they by their mutual *Symbolums*, prepare the *Pabulum* of the Animal Spirits. But the Muscles designed for Motion, especially Voluntary (in as much as the most perfect and refined Actions of the Soul, are performed and expressed by Muscular Motion,) are of a more noble use, the perfection of Man consisting more immediately on the energy and execution of the Principal Faculties of the Soul, than in the subordinate and subservient Faculties, both Natural and Vital.

For as much as the Life and Perfection of Man, so much depend on Muscular Motion, I shall

shall enquire into the Efficient Causes of it : But before I propose my own Hypothesis, it is necessary that I first confute what has hitherto been said on this subject ; nevertheless, because it would be too tedious to examine the Opinions of so many Authors, I will only shew the Errors of Two or Three of the latest and most considerable.

The most Learned and Famous Dr. *Willis* Conjectures, that *Dr Willis's Opinion examin'd.* the Spirits are conveyed to the Tendons of a Muscle, and are there plentifully laid up as in a convenient Store-house ; which Spirits be-

B 4 ing

ing of an Agile and Elastick Nature, as far as they are able, and are permitted, always endeavour to expand themselves; and that when an Instinct to perform Muscular Motion, is carried from the Brain or *Cerebell*, to this common Storehouse, they presently leap out of the Tendinous, into the fleshy Fibers, where they meet with active Principles of another Nature, supplied by the Mass of Blood; which two strongly & mutually fermenting, stuff up and tumifie the Fleshy Fibers; whence proceeds the Contraction of a Muscle. When the Contraction ceaseth, he thinks that most of the purest Spirits that remain, return into the Tendons, the other more
 impure

impure Particles remaining amongst the Fleſhy Fibers ; he fancies, that the Fibers of the outward Membrane contracting , promote the Retroceſſion of the Spirits into the Tendons ; and that for a continual ſupply of theſe Liquors , the one is always ſtored up in the Tendons, through the Nerves ; and the other in the Carnous Fibers , from the Maſs of Blood.

This Conjecture as it ſeems ingenious , and at the firſt view very myſterious , yet upon a more ſtrict Examination, it appears altogether as improbable. For to ſuppoſe that theſe Elaftick Spirits are laid up, and ſtored in the Tendi-

*No Elaftick
Spirits laid up
in the Tendons.*

nous Fibers, is contradictory to Reason, as well as the Laws of Circulation; for since in every Systole of the Brain, a fresh supply of Animal Spirits is sent into all the Branches of the Nerves, those Animal Spirits in the Tendinous Fibers, must needs by a succession of new matter, be pressed forwards into the Fleshy Fibres; and consequently Accidental Contractions must follow: for as much as there are no Valves to hinder their immediate Passage. And that there are no Valves, nor any thing else to stop the continual Passage of these Spirits, may be argued hence; because whatever would stop the protrusion of these Spirits, when pressed by the Systole

stole of the Brain, would also hinder 'em from rushing out of their Store-house, though stirred up by an Instinct, and so the Muscle would be deprived of Motion.

But supposing that it were possible for these Elastick Spirits, to be stored up in the Tendinous Fibers, and that neither their agility, and continual Endeavours to explosion, nor the force of succeeding Spirits would drive 'em out; yet when a Muscle ceaseth from Motion, perhaps a Day or Two; the Tendon would be so filled and stuffed up, that being no longer capable of receiving more Spirits, either they must be forced forth into the Carnous Fibers, and cause violent and Involuntary

tary Contractions ; or regurgitating and flowing back upon the Brain, would there cause a *Vertigo*, or some other more fatal Disease ; and besides the Spirits by stagnating so long, would be chilled and coagulated, and thereby render'd unapt for Motion.

It is not only absurd to imagine, that the Tendons, are Store-houses for Spirits ; but also that they, the Instinct being given, should rush out of the Carnous Fibers ; one might as well think, that the Contents of the Stomach, the Gall in the *Vesica Biliaria*, or the Urine in the Bladder, might be excluded by instinct, meerly without the help

*Nor instinct
sent from the
Brain, because*

help of Muscular Coats; or that the Circulation of the Blood might be carried on, without the Systole and Diastrale of the Heart.

Moreover, to allow, that those Elastick Spirits do after this manner rush into the Carnous Fibers,

Either it implies, that the Spirits are Intelligent,

when the Instinct is given from the Brain, or to speak more properly, *ad imperium animæ*, either implies, that those Spirits, which Dr. Willis calls *Materiam subtilem*, are intelligent Matter; that they are able to understand the Dictates and Commands of the Soul; and to put them in Execution, *proprio motu*; or that some Spirits
of

Or that Spirits of a Different Nature are sent from it.

of a Different Nature, are at the command of the Soul, sent from the Brain, which cause the Spirits in the Tendons to be uneasy, and by exagitation to expand themselves more powerfully, and consequently to leap forth. But if neither the texture of those Spirits, which as *Dr. Willis* says, give the Instinct, be changed, and different from those in the Tendons, nor the Subtile Matter be Intelligent, there would be no Explosion, or leaping forth of the Spirits out of the Tendons, either by instinct, or the accession of new Matter from the Nerves; except, as I noted before, the Spirits which filled the Tendinous Fibers,

Fibers, were driven, and successively forced out by a fresh supply of Spirits, sent in by every Systole of the Brain; and so, Muscular Motion would not be Voluntary, but Accidental.

That this Matter is not Intelligent, is proved sufficiently; be-

*The Matter
is not Intelligent.*

cause to allow that this acts as it receives Instinct from the Brain, is to allow a subordinate Soul which acts *propria facultate* in every Tendon; which is false; for an Intelligent Faculty in a Tendon, which must act according to the Dictates of the Principal Soul, cannot be supposed to be a Faculty of that Soul, no more than the Soul
of

of a Disciple, *Juratus in Verba Magistri*, and who exactly follows the Dictates of his Master, can be said to be a part or faculty of his Master's Soul.

That no Spirits of a different Nature from those he supposes to be in the Tendons, can be transmitted from the Brain, is evident. For since the same Spirits are distributed through all the Nervous Channels, from the same Fountains, the Brain, or the Spinal Marrow, whatever causes the Spirits to leap out of one Tendon, would cause the same Effects in all, and all the Muscles must be contracted at the same Instinct.

*No Spirits of
a different Na-
ture are sent
from the Brain.*

Having

Having thus confuted the Grounds and Foundation of his Hypothesis, it's not irrational to expect, that the whole Superstructure should fall: I shall only further take notice,

First, That if Active Principles of another Nature were heaped up in the Fleshy Fibers, by degrees they would be so stuffed and swelled up, that there would be no room for the entrance of Elastick Spirits from the Tendons; but they themselves would rather, by reason of their quantity, be forced into the Tendinous Fibers.

No active Principles heaped up in the Fleshy Fibers.

Secondly,

Secondly, That it would be

*Nor retroces-
sion of subtile
Matter into the
Tendons.*

absurd to imagine, how these Two Spirits after so intimate a commixture, as would be produced by a strong Fermentation, can be so easily separated, that the one should suddenly run back into the Tendons, leaving the other behind in the Fleshy Fibers: For when Two Liquors of a different Nature, and whose Minute and Subtile Particles have a different Motion, are mixed together; by a mutual Fermentation is produced so intimate a mixture, that it is impossible to separate the one from the other sincere; because by a mutual collision of different Particles, both must needs in some measure be

be altered, and degenerate from their Pristine State, so that if the purest part of these Spirits remaining should run back into the Tendons, they would be disagreeable to, and different from those purer Spirits sent from the Brain; and would infect the Store-houses with such a fermentative taint, that as new supplies were laid down by the Nerves, fresh Explosions and Contractions of the Muscles must follow.

Thirdly, To help the Retrocession of these Spirits into the Tendinous Fibers; Dr. *Willis* would have the Fibers of the investing Membrane to contract: But I should rather think, that they would contract at the same time with the Muscle, if the Instinct

strict were carried through the same Nervous Channels with the Spirits ; because, as he says, they are first laid down in the Membrane, and thence conveyed to the Tendon?

Mr. Cowper, in the Introduction to his *Myotomia Reformata*, suspects ; that the Blood is a Pondus, by which the action of a Muscle is performed : The grounds of this suspicion are chiefly taken from two Experiments : The first is a Ligature on the descending trunk of the Aorta, whereby all the inferior Parts, became destitute of Motion, which they recovered again when that Ligature was loosed : The second, is

Mr. Cowper's
opinion examined.

to be taken for a more surprizing Argument, because after a cessation of Motion, the Muscles of the Legs renewed their Contractions, by an Injection of Water into the Crural Arterie.

But that there is no Reason to assert, that the Blood acts as a Pondus from these Experiments, will hereafter sufficiently appear, by giving other Reasons for these *Phenomena*.

In the mean time to evince, that the Blood as a Pondus does in no wise help the Contraction of a Muscle, but does on the contrary, much interrupt and resist the Intumescence of the Musculous Fibers, by which the Contraction of a Muscle is performed, let any

The Blood does not act as a Pondus.

The First Argument.

one

one hold his hands before a Fire, with his Arms perpendicular, continuing 'em in that posture till he feels the Musculous Parts well filled with Blood; then lifting up both his Hands, let him hold 'em up as high as he can, till the Pondus of the Blood be drained, and the Veins which before were full and tumid become flaccid and empty, and he'l move his Fingers much more easily and swifter, when the Muscles are eased of the Pondus of Blood, than he did whilst his Hands were dependent; yet certainly there was a greater Pondus of Blood upon the Muscles in the former posture, whilst they were tumid, than in the latter when emptied of superfluous blood.

Ano-

Another Argument to prove,
That the Pondus of
the Blood doth not

A Second.

at all promote the Contraction
of a Muscle ; may be taken from
the Observation of Cacochy-
mick Bodies, who are far more
dull and unapt for Motion than
healthful people, whose Veins
and Arteries are moderately fil-
led with Blood, which is not so
thick and heavy ; for in Caco-
chymick Bodies, there is a grea-
ter Pondus of Blood, but because
it doth not yeild matter for to
swell the Carnous Fibers, as
plentifully as blood of a more
healthful constitution, Motion
is not so brisk and strong ; where-
as if the Pondus of the Blood
did any ways contribute to the
performance of Muscular Moti-
on,

on, they would be far more strong; for the thicker the Blood is, the greater is the Pondus.

In the Muscles of the Legs and Thighs there is
A Third. always, when the Body is erect, a greater weight of Blood, than on the Muscles belonging to the Hands and Arms; and yet the latter, are far more agile and nimble in Motion.

Again, if we but make a Ligature two or three fingers breadth above the Cubit, so as to hinder the Reflux, but not the Influx of the Blood; when the Sanguiferous Vessels are swelled, and the Muscles well filled, they are rendered much more unapt for Motion: Which evidently shews that the more the Sanguiferous

ferous Vessels are distended, the more the Motion of a Muscle is hindered ; because when the Vessels are dilated they resist the Intumescence of the Carnous Fibers, and consequently the Contraction of a Muscle.

Furthermore, That the Contraction of a Muscle is not perform'd by the Pondus of the Blood, is apparently evident in the following Experiment : *Viz.*

Make a Ligature

A Fifth.

two or three fingers breadth above the Cubit, so strong as to stop the Circulation of the Blood ; then open the largest Vein with the common instrument, and the Blood which more than usually swelled up the Sanguiferous Vessels will leap forth ; but presently for want of

C

subse-

subſequent Matter, and due Circulation, the Vein falls and the Blood ceases to run; yet by a Contraction of the Muscles to which that Vein leads, forthwith part of the Blood, which lay in the Muscle, is forced out: which plainly shews there is less Blood in a contracted Muscle, than before Contraction.

The same appears also in Running, or any other violent Exercise, in which most of the Muscles are Contracted; for presently the Blood flows more than usually upon the tender Lungs, and causes an Intollerable shortness of Breath: Because by an Intumescence of the fleshy Fibers, the Muscles are not only made incapable of receiving so much Arterial

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erial Blood as before Contracti-
 on ; but also, because the Blood
 which lay in the Veinous Ducts
 is driven out more forcibly upon
 the Heart, and the Heart being
 overwhelmed, drives it out up-
 on the Lungs. Whence proceeds
 that Palpitation of the Heart
 upon violent Motion, not di-
 rectly as Dr. Creone supposeth,
 because an Instinct is sent from
 the Brain to raise stronger Pul-
 sations, that the Blood may for-
 cibly be driven into the Mus-
 cles, and thereby cause Contra-
 ctions ; for then why doth it
 not at the first Instinct thus op-
 press the Lungs with its quanta-
 ty ? but this strong Palpitation
 is Accidental ; for when the
 blood is more than usually dri-
 ven upon the Heart, and not so
 plentifully

plentifully received by the Muscles; by degrees it oppresses the Heart with it's quantity, and the Animal powers being sensible of the oppression, raise stronger Systoles to drive it out which presently is received and heaped up in the Lungs as a Part less able to resist its violent Incurfion. Nay many times, when the Vessels are well filled with Blood, by violent and frequent Exagitations, betwixt the Contraction of the Heart and of the Muscles, its texture is so loosened; that it ferments and boyles up so that the Lungs are not only swelled up and almost stifled, being rendered incapable of receiving Air, but it is also more strongly & forcibly driven into the Muscles themselves, and there

there distending the Sanguiferous Vessels hinders the Intumescence of the Fibers, and thereby the Contractions of the Muscles So that I have not once, trying this Experiment, found such an Oppression on my whole Thorax; and such contrary and in some measure painful endeavours, betwixt the Sanguiferous Vessels tumified and the Carnous Fibers striving to swell; that I was forced to lay me down, to the end that the Carnous Fibers being flaccid might give way to the incourse of the Blood; and by receiving it more plentifully might ease both my Thorax of its Oppressions; and that the Carnous Fibers yeilding to the Sanguiferous Vessels might put an end

to that uneasy contention. Thus much I think is sufficient to prove, that the Blood as a *Pondus* hinders the Contraction of a Muscle.

Dr. Ridley supposes, That the Nervous and Carnous Fibers are only a Congeries of Fluids contained in certain Vessels; and that by Reason of a Plenitude in the aforesaid Vessels, the whole Machine is in a constant *Æquilibrium*, so that it will follow, upon the common *Postulatum*, viz. That the Sensitive or Rational Soul can command the Animal Spirits into a *primus impetus*; and that part of that Liquor, whenever a Muscle is Contracted, is transmitted

Dr. Ridley's
Opinion examined.

mitted through the Vessels from the Brain to its Carnous Fibers, and causes the Intumescence of a Muscle; the same Liquor at the same time being driven back with an equal speed from the Antagonist Muscle, into the room of the former, which was transmitted from the Brain to the Contracted Muscle, to avoid a Vacuum.

That the Nervous Ducts as well as Carnous Fibers are always Watered with a Fluid; and that the Nervous Liquor equally flows into the Branches of all the Nerves, according to their Proportion, is beyond Contradiction; but if we allow the common *Postulatum*, we must also conclude,

*The common
Postulatum is
not to be allow-
ed.*

That *the Animal Fluid* is Intelligent, and there will follow the same Difficulties as were before mentioned, about the leaping forth of Spirits out of Dr. *Willis* his *Tendinous Receptacles*; where I have given sufficient Reasons to reject this *Postulatum* as Impossible.

Moreover if it were Possible, for so much of this *Animal Fluid* as is requisite to distend the Carnous Fibers, to be conveyed in so short a time as Muscular Motion follows our Appetite through the small Branches of the Nerves; yet it would be altogether unconceivable, how it should flow back from the Antagonist, thus contrary to the

There is no Retrocession of a Fluid from the Antagonist.

the Course of Circulation ; but the Reason he gives is partly this, to avoid a Vacuum : This is a most Stupendious sort of a Motion ; at the same time that the Liquid is forced into the one Muscle , it runs directly opposite from the Antagonist ; which is very irregular and unlikely.

Besides, I cannot understand how it comes to pass, that the Animal Fluid is so much forced out of the

*Nor is it
forced out so as
to cause a Vacuum.*

Branches of the Nerves leading, to the Muscles to be contracted as to leave a *Vacuum* for the Reception of Liquids from the Antagonist ; but if an Emptiness or Vacuum could be so made, the Fluids would as soon be drawn

back again, out of the Muscles into which our Appetite directed them, to fill that empty Space, as out of the Antagonist.

To prevent an Objection against his Supposition, that the fluid runs back again from the Antagonist, he thinks he has answered it already, but very insufficiently : He says, if it be said, that the Reflux is opposed by the constant direct Motion, it's easie to reply, that it's slow direct Motion, is easily repelled, by the violent impulse of the forcibly relaxed Muscle. I must confess, it's no piece of difficulty to make such an Answer ; but the Reply seems not so easily to give satisfaction ; I would fain know
how

how the Antagonist comes to be so forcibly relaxed, as by a violent impulse to overpower the direct Motion: For the direct Motion cannot be so weak, as to be easily overcome; and since the Animal Fluid, as he calls it, is continually driven by the Pulsation of the Heart, through the Brain or Spinal Marrow into the Nerves, whatever repels the direct Motion, must be of equal, if not greater, force than the Systole of the Heart.

He begs leave to ask, how when another bends his Arm against his Will, the Muscles become tumid, as when voluntary contracted. This Question doth not at all confirm his Hypothesis, but on the contrary
pleads

pleads against it. It doth not confirm it, because he doth not account for the *Phænomenon*, nor give a Reason agreeable to his Opinion, but leaves the thing barely without explanation; it pleads against him, because according to his Opinion, the Muscle instead of growing tumid, ought violently to relax, at least to endeavour a relaxation, and not contrary to the Appetite, to run into a Muscle against our Will: For he says at the same time, that the Muscles to be contracted, grow tumid; the Antagonists by a violent relaxation, drive out the fluid contained in them: So that it will follow, that at the same time we endeavour to keep our Arm unbent, by
 striving

striving to keep the one Muscle contracted, at the same time we ought to endeavour a relaxation of the Antagonist ; and though that force which bends our Arm, doth resist the Voluntary Contraction of the Muscle , yet there would nothing hinder the voluntary Relaxation of that Muscle, which is the Antagonist, but the slow direct Motion , as he calls it.

But here I humbly take leave to ask, whether there is not a great deal of difference, betwixt a Muscle that is thus tumid, and one that is Contracted ? For altho a Muscle cannot but be tumid, when contracted, yet it may be tumid though not contracted : I mean, as it is in Muscu-

Muscular motion. I have indeed oft taken notice, that when my Arm has been bent against my Will, the Muscles become tumid, but not as in Muscular Motion ; for when a Muscle is Voluntarily contracted, it's hard and tumid ; but when my Arm is bent against my Will, it's far more soft ; and though tumid, yet very little contracted. Since the Reason why the Muscles grow thus tumid, cannot be accounted for by this Hypothesis, I shall explain it hereafter.

Having thus examined, and I hope confuted the aforementioned Opinions, I shall in the next place briefly consider the Fabrick of a Muscle, the immediate

mediate Instrument of Motion.

Anatomists, describing the Fabrick of the Muscles of the Body, divide 'em into Simple, Compound, and more Compound; as also every Muscle into Three Parts, the Head, the Belly, and the Tail; they acquaint you how the Belly is composed of several *Fasciculi* of Fleshy Fibers, which lie parallel to each other, &c. of which enough may be seen, with a full Description of each sort of Muscles in the Original Authors: I shall omit the Repetition here, and only take Notice of it's Fabrick, as far as relates to my Hypothesis.

Every

Every Muscle is endowed with opposite Tendons, which are composed of several *Fasciculi* of Fibers, lying parallel to each other.

Of the Structure of a Muscle.

These Fibers being strictly joyned together, compose a strong, tenacious and firm Tendon; but being separated one from another, are more fragile, and subject to be easily broke, and pulled in pieces; they are continued from each Tendon to it's opposite.

The Interstices of the Fibers thus separated, are filled with the Branches and Extremities of Vessels, the major part of which are Sanguiferous; so that the Fibers continued through the Belly of a Muscle, being
obscured

obscured by the colour of the Blood, seem to degenerate from the Tendinous Fibers, and therefore are called Fleſhy.

Theſe Fibers as they are continued from each oppoſite Tendon, ſo alſo there is a continued Cavity from one end of Every Fiber to the other; which being partitioned by ſeveral tranſverſe and perforated Membranes, every Fiber, according to Dr. Croone, reſembles a continued Series of Bladders opening one into another.

By an Intumeſcence of theſe Fibers, they are contracted in length; and by a Contraction of their Longitude, each Tendon is drawn nearer

*The formal
cause of the contraction of a
Muscle.*

nearer to its opposite ; which is the formal cause of Muscular Motion, as far as can be made evident by *Autopsie* : This is so unanimously assented to, and so apparent to the naked Eye, that it requires no further proof.

As for the Efficient Causes of Muscular Motion ; before they can be sufficiently shewn, we must enquire how many sorts of Vessels are implanted into each Muscle, which according to Anatomists are Four, *Nerves, Arteries, Veins* and *Lymphæducts* ; the *Nerves* and *Arteries* furnish the Muscles with Spirits and Blood ; the *Veins* and *Lymphæducts*, carry back

*Vessels im-
planted into a
Muscle.*

back the superfluity of Blood and Lympha.

The Branches of all these Vessels are minutely distributed through the whole

Their distribution.

Muscle, and by an intermixture and texture of the most Minute and Subtile Branches of the same, is formed that Substance, which fills up the Interstices of the Fibers, and which denominates the whole Belly of a Muscle Fleshy. The colour of these Vessels, as of all others, is without doubt White, but by the Contents of the Sanguiferous Vessels, the whole Belly of a Muscle is coloured Red.

The Terminations of these Vessels are so minute and small, so brittle, and subject to be broke,

broke, that it's as difficult to trace, and find their Terminations, and Insertions, as to divide a Hair into an Hundred Parts; and though many things are made visible by the help of Microscopes, which are otherwise too subtile to be discerned and discovered by the naked Eye; yet I am not without Reason perswaded, that the terminations of these Vessels, cannot be perceived by the help of a Microscope.

Some indeed, whatever they think is probable, lest it should not be credited, presently strenuously affirm, they saw it with their Microscopes; and so easily impose on those that less inquire after truth themselves, but take it on trust from others; and perhaps

perhaps prevent those not so exquisitely skill'd in Microscopes, from making any further search after truth. I shall not here say, that what I propose concerning the Terminations of these Vessels, was seen with any Microscope, but shall declare my Opinion in this Matter, too subtile for any Microscope but Reason.

It being impossible for any one to understand the true Reason of *And terminations in small Glands.* Muscular Motion,

unless first acquainted with the distribution of these Vessels, and their Contents; first, I conceive, that as the Nerves, Arteries and Veins, are all distributed through a Muscle, so it is but Reasonable to conclude, that

that their minute and subtile twigs are all, before they terminate, interwoven and mixed with one another: And if so, it will not be absurd to imagine, that they all end, as it were, in small and *Diminutive Glands*: And if the ends of the Vessels be so small, that their terminations cannot be perceived by a Microscope, these *Glandules* composed of the Invisible ends of the aforesaid Vessels, must needs be very small and fine, and consequently may not be perceived by the help of extraordinary Microscopes.

From these *Glandules* thus formed, are derived short *Ducts* or Passages, for the conveyance of a subtile Liquor, out of the aforesaid *Glandules*, into the Cavities

Cavities of the Carnous Fibers. This Passage very likely, may be composed of the external Arterial Coat. Into the Cavity of the Carnous Fibers, besides these *Ducts*, the twigs of the *Lymphædrits* are also inserted, to carry back a superfluous *Lymphædrit*.

If any one thinks it improper or absurd to assert, that these Vessels *Proved.* do thus terminate, as if it were in small *Glandules*; let him but consider what a Gland is, and how it is composed, and he will not think the Conclusion irrational.

For a Gland is nothing else, but a Composition of an Infinite Number of small and di- *What a Gland is.* minutive

minutive Vessels, several, and most of which, have Communication one with another; which Gland so composed, is as a Store-house to receive and contain a certain Liquor, till necessity requires, or its quantity causes an exclusion of it: And this seems plainly to be favour'd by Dr. *Ridley*, when he says, that the whole Body is a continuity of Vessels, *ad infinitum*. Now, if a Gland consists of an infinite Number of small Vessels; and if the Branches of Nerves, Veins and Arteries be divided before they terminate, into an innumerable number of most invisible twigs, as is most certain; when from one twig of each sort, is derived a vast number, and

and all these so derived, are mixed and interwoven one with another; why may we not say, at least Metaphorically, since they in their Distributions imitate the Composition of Glands, that they terminate in small Glandules.

Some perhaps will ask, how must we discover these Glands? *Malpigi* hath observed the Liver to be composed of Clusters of Glands, hanging at the Extremities of the larger Vessels, like so many Bunches of Grapes; and the Glands in other parts are apparent; but in a Muscle we can discern no such things; for it, especially when boiled, parts into distinct Carnous Fibers.

D To

To which I Answer, That
Why they cannot be discerned. those Glands are
 nothing else but a
 Composition of the
 ends of importing and export-
 ing Vessels ; and the Reason why
 we cannot discern the same in a
 Muscle is this, because the Ex-
 tremities of the Vessels are so
 fine, and consequently so brittle,
 and are contained in the Intersti-
 ces of so strong and firm Fibers ;
 that whenever we endeavour a
 separation of the Fibers, the
 Glandules are torn away from
 the Vessels from which they are
 derived ; whereas the Fibers
 which run transverse the Li-
 ver easily crumble away, being
 much more weak and less Nu-
 merous.

The

The Reason why the Muscular Fibers are so much stronger, than those that run through the Liver, is apparent enough, *Viz.* because the former are the Instruments of Motion, and consequently there lies a greater stress on them, than on the latter, which serve to make the Part a little more compact, and to keep the outward Coat from being loose upon it's Circumference.

Now because it is impossible to separate and remove these Muscular Fibers, so as to leave the Sanguiferous Vessels as entire as would be requisite for the exact and certain discovery of their Terminations; and because it is certain, that these Vessels are divided, and subdivided

vided *ad minimum*; that they are interwoven one with another, and that a Gland is nothing else, but a Composition of Vessels; we may rationally conclude they all Terminate in *Diminutive Glands*.

The Nerves, Veins and Arteries, composing and ending in these Glands; I shall next Enquire, to what end they do all thus meet together.

The Use of the Nerves in these is the same as in other Parts,
The Use of the Nerves. *Viz.* to convey a

Spirituo-saline Liquor from the Brain: Which Spirits being Volatile and apt to Ferment, when mixed with a Liquor of a contrary Nature, are continually sent by the Systole of the

the Brain into all the Muscles of the Body, and being laid down forcibly in the aforesaid *Diminutive Glands*, do there meet with

And Arteries inserted in the Glands.

Arterious Blood driven in by every Contraction of the Heart : Which two Liquors strongly fermenting together, the Animal Spirits do by an Attrition Subtilise, Attenuate, and Rarifie those Particles of the *Succus Nutritius* supplied from the Mass of Blood ; by which Means their own are much dulled, and become less Active for the future ; and by a Mixture of these Animal Spirits, with the rarified *Succus Nutritius*, results a *Liquor* Different from, and of a middle State betwixt, the

To prepare a Liquor different from the Spirits or Succus.

Animal Spirits, and the said un-fermented *Succus Nutritius*; which *Liquor* thus compounded and prepared, is driven by a Succession of Matter through its proper *Passages*, into the Cavities of the *Fibrous Cells*, the remaining and more crude Part of the *Succus Nutritius* being received together with the Blood, and carried back to the Heart.

This *Liquor* after this manner conveyed to the Cavities of the Fibers, does as it passeth, and is thrust through according to the continual Laws of Circulation, give nourishment to the Parts, and is thence received by the *Lymph ducts*.

Thus

Thus I conceive it is continually prepared in the *Glandules*, and Circulates through the Carnous Fibers of all the parts of the Body, whilst Motion ceaseth in a moderate quantity; so that the *Lymphæducts* are capable of receiving it, and thereby prevent the Præternatural Repletion of the Fibers.

To prove what I have hitherto said, besides the *Verisimilitude* the thing carries with it, I could bring many Arguments to illustrate, and to make it appear more Plausible and Evident; but for Brevities sake, and to prevent unnecessary Repetition, I shall omit 'em here, because they are to be Mentioned hereafter.

I have given a breif Account of the Structure of a Muscle, as far as relates to my Hypothesis, and the Use of the Parts, as they serve to Nutrition. I now proceed to the Efficient Causes of Muscular Motion, both Voluntary, and Involuntary ; and first of the Reason of Voluntary Motion.

That Voluntary Motion does depend upon the Dictates of the Soul, and is the Result of it's Faculties, but more immediately of our Appetite, is sufficiently Evinced ; because it's instantly perform'd according to our Will. Where the Soul is lodged ; how, and after what Manner, it Operates ; and what it is) is most difficult to determine

mine, and is not designed for our present enquiry : But as it comes under the Consideration of the Brain, and it's appendages ; I shall defer my Thoughts of that, till I have a further Opportunity.

In the mean time, That neither the Soul, nor any of it's Faculties are the immediate Causes of Muscular Motion, but Operate by the Mediation of the Animal Spirits, will appear from what follows concerning the Reason of Voluntary Motion : And that the Office of the Will, is only to open and shut the Pores of the Brain, by an Organical Motion, as necessity requires, what this Motion is, and how it is performed, and after what manner

the Dictates of the Soul and of its Faculties are put in Action, is reserved for its proper Seat.

After what manner soever the Soul exerts it's Faculties, and directs that Subtile Matter the Animal Spirits (which is sent through the Branches of the Nerves, in greater or less quantities according to our Appetite) to this or that Part; it is allowed, that when our Body ceaseth from Motion, and all our Voluntary Faculties are at quiet, the Pores and Passages of the Brain leading to the Instruments of Voluntary Motion are locked or closed up : And then I suppose, that the Spirits moderately flowing into each Muscle, do prepare so much of the *Subtile Liquor* aforementioned
as

as is sufficient to Nourish the Parts as it passeth through 'em.

But when the Pores of the Brain are opened,
and unlocked, the

*The Reason of
Tonick Motion*

Animals Spirits forced by a continual Succession of Matter, flow into all the Branches of the Nerves more plentifully, and being laid down in the *Glandules*, raise a stronger Fermentation; by which means a greater quantity of the Subtile *Liquor* is prepared, and forced into the fleshy Fibers more copiously and rather faster than it can be received and evacuated by the Lymphæducts; so that the Fibers being all equally swelled with its quantity, consequently Contract the Muscles;
which

which is the Cause of a Tonick Motion.

When these Animal Spirits, are by a pressure and Systole of the Brain and succeeding Spirits, sent yet more plentifully into the Nervous Channels leading to the Muscles to be Contracted, than into those which are in *Motu Tonico*, or into the Antagonists (the Passages and Pores leading to those Nerves being yet more expanded and opened) there is a greater quantity of the Subtile Liquor prepared in the *Glandules*, and thrust out into the Carnous Fibers; and their Cells being more swelled and dilated, consequently there follows stronger and more violent Contractions of the Muscles; whence

whence proceeds Local Motion.

By the Syftole of the Brain I don't mean any other Motion than what proceeds from the Pulsation of the Arteries distributed through that Part. That this motion only proceeds from the Pulsation of the Arteries implies, that it is stronger, & drives the Spirits through the Brain into the Nerves with greater force than if it were really the Motion of the Brain it self, the Heart from whence the Pulsation of the Arteries proceeds, being a stronger and more compact Part as to its Substance, than the Brain.

If it be asked, why this *Subtile Liqueur* is not more easily forced into the Venous Ducts, than into those that lead to the
Fi-

Fibrous Cells, because the former are larger ?

I Answer, That the Venous Ducts are so proportioned, that they might not be capable of receiving all that is laid down by the Nerves and Arteries; on purpose, that some Subtile Parts might be continually driven into the Fibrous Cells; and when by a more copious Influx of Animal Spirits, a stronger Fermentation is raised in the *Glandules*; presently the Contents swell up and are expanded; so that the Veins being not able to receive them as before, more of that *Liquor* is not only subtilized, but forced into the Fibers.

As soon as, according to our Appetite, the Pores of the Brain, which conveigh Spirits to the Nerves

Nerves leading to the Contracted Muscles, are shut more closely up again, and leave of to be dilated; the Animal Spirits cease to flow more into the Musculous *Glandules*, than are required to Subtilize, and prepare a sufficient quantity of Nourishment for the Fibers (as in the Antagonist,) then presently the Contraction ceaseth to be carried on, and the Superfluous *Liquor* heaped up in the Fibers, is evacuated by the Lymphæducts.

Here perhaps, because I said in the foregoing Paragraph; the *Liquor* Objections Answered. heaped up in the Fibers is Evacuated by the Lymphæducts; it may be a Question whether this *Liquor* does all the time a Muscle is Contracted, constantly

ly flow through these Cells into the Lymphæducts ; or whether it remains in the Cells till Motion is to cease, and is not evacuated by the said Ducts till then.

I say it does continually run of by the Lymphæducts, constantly a'l the time a Muscle is Contracted : Otherwise since as long as Spirits are directed, in a competent quantity, to the Contracted Muscles, to keep up the Dilation of the Fibers ; they would presently be incapable of receiving it, and it must needs Regurgitate as it was prepared, and in a great Measure disturb Circulation. But to prevent many absurd Consequences, if it should remain in the Cells so long ; I affirm, that it is constantly

stantly forced forward, by a Succession of Matter ; and as it is forced into, and Circulates through, these Cells, in greater or less quantities, so Contractions are stronger or weaker or not at all, the Fibrous Cells being accordingly Distended, Dilated and Contracted in Longitude ; and when according to our Appetite, this *Liquor* ceaseth to flow into the Fibers in so great a quantity as to Contract the Muscle ; that matter which before dilated the Fibers, is Evacuated, as being Superfluous Nourishment, so that for the future it runs through in a moderate quantity as before Contraction, till their Repletion is again renewed to Reiterate Motion.

If

If it be asked, why this *Zi-
quor* is not as easily forced back-
wards out of the Fibrous Cells
into the *Glandules* from whence
it came, as into the Lymphæ-
ducts; and so think there
would be no need for Lym-
phæducts.

I answer, That if there be no
Valve at the inward Orifice of
every *Duct*, to hinder its re-
flux; (which would be no ab-
surdity to conclude; for we
see always upon the like occa-
sion, Nature hath furnish'd such
Places with Valves;) yet I say,
if there were none, the direct
Motion of subsequent Matter
from the *Glandules*, would suffi-
ciently hinder the reflux of it;
and since its reflux is opposed,
by new matter forced successive-
ly

ly after it ; and since according to the course of Circulation, the Matter driven into the Lymphæducts before it, will give way for its expulsion, it would be more reasonable to imagine, that the matter contained in the Fibers is evacuated *qua datur porta*, rather than *qua non datur* ; for when we design the Relaxation of a Muscle, though the Liquor successively sent from the *Glands*, does not press forwards altogether as forcibly, and in as great Quantities, as whilst Contraction is continued ; yet it follows moderately, so as to oppose the Retrocession of any thing ; I mean moderately, as to its quantity ; for the continual violent concurrence of the Animal Spirits,

Spirits, and Arterial Blood, drive it then into the Fibers, almost as violently as when the Muscle is contracted.

That these *Lymphæducts* do thus receive this Subtile Liquor; and that for that end they are inserted into the Fibrous Cells, I am perswaded; because it cannot otherwise be understood, how the Matter that stuffs them up, and causes Contraction, could be drawn out again, without a Retrocession through the same Channels by which it was brought in: And though the most Learned and Famous Dr. *Willis*, Dr. *Ridley* and others, do allow a Retrocession, yet since it contradicts the course of Circulation,

tion, we must either deny Circulation, or reject their Opinions.

Besides, I cannot conceive, what other occasion there is for Lymphæducts in a Muscle; since whatever is brought by the Arteries, might as well be returned by the Veins, as by two sorts of Vessels: But for as much as Nature hath made nothing in vain, and since there is so great necessity, that they should be inserted into the Cells, I think it not irrational nor absurd, to conclude they were designed for the afore-mentioned end.

That we may understand a little better the Nature of this Liquor,

The Nature of the Liquor consider'd, and the manner of its preparation.

which

which we have so often mentioned ; let us consider a little more fully, how that Fermentation is carried on in the said *Glandules*. It's commonly known, that when a Ferment is put to a Mass, whether Liquid, or of a solid consistence, whatever is the nature of the Ferment, it, according to its power, always endeavours to render whatever comes within the Sphere of its

By Fermentation.

Activity, as like it as possible. So in these *Glandules*, the

Animal Spirits fermenting with the Arterial Juice, and the Nature of 'em being, according to *Dr. Willis* and *Diemerbroeck*, *Spiritu-Saline*, composed of Volatile Salt and Sulphur, they by Reason of their absolute
Quality,

Quality, more readily mix with the crude Sulphureo-saline Particles of the *Nutricious Arterial Juice*; and as they are more or less in quantity, so they exalt and carry forth into a Flux, more or less of that Crude Sulphureo-saline Mass; which, being by Fermentation subtilized, is diluted with a sufficient quantity of *Lympha*, or the watry part of the *Serum* of the Blood, and the *Liquor* resulting from that Composition, is thrust out into the Fibrous Cells.

That this *Lympha* might be thin enough to dilute the said *Liquor* sufficiently, it is much attenuated in that Fermentation.

That

That there is such a Fermentation, that the Nerves
Proved. are inserted into the
Glandules , and lay down Animal Spirits , as the Principal Cause of that Fermentation ; that the Arteries lay down Blood together, with the aforementioned *Juice* , and that in those *Glands* , a subtile *Liquor* is prepared, being composed of Animal Spirits , and the most rarified parts of the said *Succus* ; that neither the Arterial Juice, nor the Animal Spirits simply can cause the Contraction of a Muscle ; but furthermore, that it is necessary that this Subtile *Liquor* should be so prepared and composed, as being capable to enter into the Fibers, and to contract the Muscle, is sufficiently

ciently apparent from what hath been said, and will more clearly be evinced by what follows.

And first, If there be a Communication of these Vessels, as certainly there is; then it must needs follow, that there is a commixture of their Contents; if there be a commixture of their Contents, then there is a Fermentation, and in that Fermentation it must needs follow, that the Animal Spirits will according to their Energie and Activity Subtilize and Attenuate the Crudest Parts of the *Arterial juice*: By a mutual Fermentation there must needs be implied an intimate Commixture, and the Result of that Commixture must needs be different from the Animal Spirits, or *Arterial juice*

E simply

simply before they are mixed ;
 so that the *Liquor* , resulting
 from the Mixture of 'em, may
 be properly called a *Subtile Li-*
quor : And accordingly as the
 Animal Spirits are more or less
 in quantity, to mix with the
Arterial juice, more or less will
 be prepared and thrust out into
 the Fibrous Cells, and conse-
 quently the Fibrous Cells must
 be more or less Tumified, and
 the Muscle Contracted, as more
 or less Spirits are laid down in
 the *Glandules*. So that all I have
 to Prove is, That neither the
Arterial juice, nor the *Animal*
Spirits can cause the Contraction
 of a Muscle, and then it will
 follow consequently, that there
 is a Communication of these
 Vessels, and for that end, in the
 aforesaid *Glandules*.

It

It hath often been found, that
 an *Atrophea* of the
 Parts will follow

the Relaxation ; &
 a Palsie the Abscis-

*The Arterial
 juice simply can-
 not cause the
 Contraction of a
 Muscle.*

sion , or Ligature of the Nerves
 leading to those Parts : Which
 sufficiently shews, that the *Ar-
 terial juice* it self, cannot cause
 the Contraction of a Muscle,
 without the assistance of the A-
 nimal Spirits ; because when the
 Animal Spirits cease to flow in-
 to the *Glandules*, for want of a
 dew Fermentation, to Subtilize
 and Prepare a sufficient quantity
 of the *Arterial juice*, the Carnous
 Fibers are not only deprived of
 necessary Recruits, and Alimen-
 tal refreshment, so that they must
 needs waste away and grow
 Languid, but also for want of a

sufficient quantity of the Subtile *Liquor*, to distend the Fibrous Cells, they become destitute of Motion.

That the Animal Spirits simply, cannot cause the Contraction of a Muscle is proved; because by a Ligature on the Descending Trunk of the Aorta, the Inferior Parts become destitute of Motion: For tho' the Influx of the Animal Spirits, be not hindered; yet for want of *Arterial juice*, the matter requisite for the Composition of this *Subtile Liquor*, is not laid down in the *Glandules*; and the Muscles, the Instruments of Motion, cannot Contract without an Efficient cause.

From

From what is contained in these two Paragraphs, it appears; that neither the *Animal Spirits*, nor the *Arterial juice*, simply can cause the Contraction of a Muscle; because when the *Animal Spirits* are hindered to flow into the *Glandules*, to Subtilize and prepare the *Arterial juice*, it is not thin enough to be driven out into the Fibers: And tho' when the Influx of the *Arterial juice* is hindered, the *Spirits* are permitted to flow in; yet by Reason of the small quantity of 'em, they run through the Fibers without distending 'em.

That this *Arterial juice* ought not, nay cannot; pass into the Fibrous Cells, till subtilized and prepared

Because the Arterial juice cannot pass into the Fibers till prepar'd by the Spirits.

by the Fermentation in the *Glandules*, is Plain ; because if it could, they wou'd be stuffed up with the quantity of it, driven in by the continual course of Circulation, so as to Contract the Muscle against our Will ; which is otherwise.

Now since the *Arterial juice* cannot pass into the Fibers till Subtilized ; and since the *Animal Spirits* are not enough in quantity ; moreover since neither of 'em, simply are capable of Contracting the Fibers, and if either be obstructed the Action is abolished ; I say since it is an Action, that depends upon the mutual Assistance of each ; it is apparent, That it must be performed by a *Liquor* resulting from a Mixture of both.

And then we must of Necessity allow a Communication of these Vessels ; else there could be no mixture of their contents; and the *Arterial juice* must be prepared before it can be forced into the Fibers, for the Reasons beforementioned : to which end it will be necessary that the Vessels terminate in the *Glands*, That their Contents may be mixed, and that this Subtile *Liquor* (resulting from a Mutual conflict of the Animal Spirits subtilizing the cruder *Arterial juice* by Fermentation, in greater or less quantities accordingly as the Spirits are laid down by the Nerves) may be prepared and made ready to be driven into the Fibers.

To promote the Fermentation, and the Preparation of this Subtile *Liquor*, the forcible influx of the Animal Spirits, and of the Arterial Blood much conduce : For be the Temper of the *Arterial juice* and of the *Animal Spirits* never so good, unless they are driven violently one against another, there would be required a longer time before they could be so mixed and fermented as they ought, but the succession of new Matter admitting no long delay, it is requisite that they should be thus forcibly driven in together ; to the end that the Spirits might be diffused through the whole Mass sooner, and that their Minute Particles, striking more violently against the fixed and compacted

compacted Particles of the Blood, might more immediately break and separate the strict Union of its Parts ; and by a violent Fermentation, sufficiently dissolve and volatilize 'em, in so short a time as the Continual Pulsations of succeeding Humors admit.

The violent concourse of the Blood and Spirits, do not only promote this Fermentation, and the separation of the Subtile *Liquor*, but also successively force the Matter prepared and separated into the fleshy Fibers : This is so highly Probable, that it needs no Arguments to make it more Evident ; it being the unavoidable consequence of a continual Circulation.

Now I have given the Reasons of Voluntary Motion, and the Efficient Causes of the Contraction of a Muscle; it will be easie to unfould the Reason of Involuntary Motion. That Voluntary Motion depends upon the Will is manifest; and that Involuntary Motion is not at all Subject to it, but is performed not only without the Dictates of our Appetite but against 'em, is so evident, that it would be superfluous and useless to dispute it: I shall only shew how it is performed, which is indeed a little more obscure.

As Voluntary Motion is perform'd, for as much as the Pores of the Brain

*The Reason of
Involuntary Mo-
tion.*

Brain are dilated according to our Appetite, so that the Animal Spirits flow more plentifully into the *Glandules*, and prepare a sufficient quantity of the Subtile *Liquor* to distend the Fibers as it passes through 'em; so those Pores, which lead to the Nerves serving to Involuntary Motion, are proportioned in such a manner, that they continually convey Animal Spirits in a sufficient quantity to cause a perpetual Motion.

These Pores being so proportioned, there is no need that they shou'd have such an Organick Motion as those serving to the Instruments of Voluntary Motion; because since they are proportioned so, as to carry Spirits in a competent quantity, there

is

is no necessity that they should be either Dilated or Contract-
ed.

To Prove that these Pores
do lay down a com-
Proved. petent Quantity of
Spirits to be carried to the
Glands, I need not bring many
Arguments; for its plain and
evident to all Practitioners in
Physick, that when the Spirits
are too much carried forth, and
exalted, as in a *Diary* Fever,
the Pulse is strong and vehe-
ment, and by a too great exa-
gitation of them, it becomes
more quick and frequent; it is
also Evident, that when the A-
nimal Spirits are depressed, the
Pulse is Weak, Slow and Rare,
as most commonly in Women,
subject to Hysterick Fits; and
when

when the Spirits by an Acute or Cronick Distemper are worn out, and almost spent, the Pulse is either *Vermiculans*, *Formicans* or *Tremens*; which are signs that Nature is almost spent, and ready to yield to the Distemper. I say this is evident enough; it is then beyond Contradiction, that a healthful Pulse depends upon a moderate Quantity of Animal Spirits, and that they continually flow into those Nerves leading to the Instruments of Involuntary Motion; and as their Quantity varies, so more or less of the Subtile *Liquor* is prepared to distend the Fibers of those Muscles.

When the Spirits are weak, or almost spent, there must needs flow a less quantity into the

the *Glandules* ; and when they are exalted , a greater ; and if Extremes either frustrate Natural, or cause Preternatural Effects, we may not only conclude , that Natural Actions are performed by a moderate Quantity , but from hence we may bring good Arguments for a further proof and confirmation of my Hypothesis about Voluntary Motion.

Since I have said, that the Spirits, by Reason of a particular Proportion of the Pores, flow continually in a just Quantity ; and that these Pores

How it comes to pass, that the Systole of the Heart, is interrupted with such frequent Diastoles.

are not subject to be Dilated or Contracted according to our Appetite ; it remains , that I should

should shew how it comes to pass, that the Systole of the Heart is interrupted with such constant Diastoles; whereas, when the Pores serving to Voluntary Contractions are open, so as to convey a sufficient quantity of Spirits, the Motion is continual and without Intermission.

The Reason of the Difference will easily appear, if we do but take Notice, how when a Vein is opened, the Blood runs out continually, without ceasing or intermission; but if an Artery be opened, it gushes out with Intermissions answerable to the Diastoles of the Heart: because the Veins are always as a common Cistern, distended with Blood; and before they can be emptied

emptied with a small Orifice, they are filled by the Extremities ; but the Blood being continually received by the Extremities of the Veins , and those Extremities being furnished with Valves, to hinder it from Regurgitation ; the Arteries are always kept more lank and empty, and are not as the Veins distended with Superfluous Blood : So that it only flows out of them , when they are distended upon violent Systoles of the Heart.

In like manner , that part of the Brain that furnishes the Nerves serving to Voluntary Motion with Spirits, is like a common Cistern full of Spirits ; and when Vent is given (the Pores being opened according
to

to our Appetite,) the Spirits are thrust forth in one constant course : But the Muscles serving to Involuntary Motion, being in continual Action, do so drain their Store-house, as to keep it more flaccid and empty ; so that the Animal Spirits, as they are prepared, are continually waved through their proper Pores ; and as one Wave follows another, so one Contraction perpetually succeeds, the *Subtile Liquor* being according to the same Rules prepared in the *Glands*, and thrust out through the Fibers.

Some of the Muscles designed for Involuntary Motion, are, in some measure, subject to our Will, so that it lies in our power
to

to retardate or quicken the succession of their Contractions, but not totally to obstruct or hinder them; as the Muscles serving to Respiration: The Reason of which is this.

The Pores of the Brain leading to the Nerves, which convey

Why the Muscles serving to Respiration, are subject in some measure to our Appetite.

Spirits to these Muscles, are so framed, that they carry Spirits to them, as to the other

Muscles serving to Involuntary Motion, in a competent Quantity; but these Pores differ from those, for as much as these have such an Organick Motion, as to contract or dilate according to our Appetite, we can by a constriction close up these, so as to deny a Passage
for

for Animal Spirits, sufficient to prepare a quantity of the *Subtile Liquor* to cause due Contractions of the Muscles; till by degrees they increase to such a great Quantity, and distend their Receptacles so long, that those are no longer capable of receiving more; till that force which drives them violently into the Receptacles overcomes the constrictive Faculty of the Pores; and then the Spirits, against our Will, break forth, and flow violently into the Muscular *Glands*.

It is easily noted, that after we have holden our Breath a long time, the first Contractions are as if Two or Three were joyned together without intermission: I mean so long continued;

nued ; which is sufficient to prove what I have said of the Muscles serving to Respiration.

For when by a Constriction of the Pores, the Spirits which ought to flow out, are kept in, and heaped up in their Receptacle, and Two or Three Contractions are by that means hindered, that Receptacle becomes like a common Cistern ; and as soon as the Pores are forced open, the Spirits running out, cause long continued Contractions, till that store is spent, and then they wave through, as before the Interrup-

What I have hitherto said, might be sufficient to prove my Hypothesis reasonable ; but to illustrate

illustrate it a little more, I shall explain some of the *Phænomena* about Muscular Motion, and give sufficient Reasons for them agreeable to my Hypothesis.

Common Experience tells us, that Old People, whose Spirits are flat and weak, are most usually subject to a Trembling of their Head or Hands; the Reason of which is this: The Fermentation in the *Glandules* is too low and weak, and doth not subtilize a sufficient Quantity of the said Liquor, to keep the Muscles in a constant Motion: The Reason why a sufficient Quantity of Liquor is not prepared, is plain; for though
their

Why old People are subject to a trembling of their Head or Hands.

their Appetite and Desire is strong enough, and endeavours to open and dilate the Pores of the Brain; yet when the Spirits are weak, it's a sign few are separated from the Blood; and if few be separated, they cannot flow plentifully into the Nerves, be the Pores never so wide.

This confirms the Reason I have given, why the Systole of the Heart is interrupted with constant Diaστοles: For the Store-house which supplies it, is always kept empty, by reason of the constant efflux of Spirits; and in Old People, the Store-house which furnishes the Nerves serving to Voluntary Motion with Spirits, is kept empty; because few Spirits are
sepa-

separated from the Blood ; and as they are separated, they are continually spent by a constant distribution of them , to prepare Nourishment in the Musculous Glands : So that when the Pores are opened wider for Voluntary Motion , for want of a sufficient Stock, they cannot flow out in a constant and equal proportion, but as they are separated, they wave through those Pores that are most ready to receive them. The Motion indeed is not interrupted with such perfect Intermissions , because this Store-house is not so clearly drein'd ; but there is a perfect Remission , because the Stock is not so copious as in Young and Lusty People to yield constant Supplies.

More-

Moreover, when the Spirits are weak, its a sign that the Blood is much depauperated, and declines from its Natural state; and then there is more need for strong Spirits to raise the Fermentation in the Glands, and to subtilize the Liquor: Upon which account, when the Spirits are weak, the Disadvantage must needs be the greater.

Hence may be deduced a Reason, why when our Spirits are low, and almost spent, though our Appetite be strong, we cannot perform strong Actions.

From hence it may be proved; that there is something prepared in these *Glands* by the Animal Spirits, which is incapable of
entring

entring into the Fibers till prepared : For whether the Spirits be weak or strong, there is a sufficient quantity of *Arterial juice* laid down in the *Glands*, tho' its not made capable of passing into the Fibers, but as it is prepared, accordingly as the Spirits are more or less in quantity, stronger or weaker.

I have known Women, who seemed healthful, and of a Sanguine Complexion, whose Hands wou'd, when they were about any Moderate Exercise, Tremble as if Paralytick : For the Mass of Blood being a little more than usually depraved, and degenerated from its Balsamick and Sulphureous, into a more crude and Phlegmatick

F

State,

Another Phenomenon Explained.

State, was unapt for Fermentation; so that the Animal Spirits being not able easily to prepare a sufficient quantity of the aforesaid Subtile *Liquor*, to keep the Muscle in a constant Motion, were forced to do it by an unequal Influx: just as an Horse, set to draw too great a Burthen, is forced by many reiterated draughts to get it forwards.

Mr. Cowper Mentions an
A Third. Experiment, how
 by an Injection of
 Water into the Crural Arterie,
 the Muscles of the Legs renew
 their Contractions. From this
 he would infer, that Muscular
 Motion is performed by the
 Blood as a Pondus; but tho'
 his *Myotomia* Argues, it came
 from an Inquisitive Author, yet

I rather am fully perswaded, that the Blood does not Act as a Pondus, because this Experiment pleads against it ; but to avoid a long dispute, I shall only give the Reason of the *Phænomemon*.

Before the Injection of this Water, the Branches of the Arteries are full of Blood, and *Arterial juice* ; and when by the mixture of the Water with this *juice*, it is attenuated and driven into the *Glands*, faster than it can be received by the Venous Channels, the most Subtile Part is by the force of Injection, strained into the Fibers and distends 'em so as to Contract the Muscle.

Perhaps here it will be objected that if the Water can thus pass through into the Fibers,

F 2

what

what need is there that the Nerves should lay down their contents in the *Glandules*.

I answer, that the Water is thin and apter to pass through those *Ducts* than the *Arterial juice*, which is thick and viscid; wherefore it is necessary, that the *Nerves* should lay down their contents there, to Attenuate and Rarifie this Thick *juice*.

I have seen People inclining
to a Dropsie, whose
A Fourth. Blood and Serum

was much diluted, could move much more nimbly, tho' more feebly, than some of a healthful Constitution, whose Blood and this *Arterial juice* was thicker and not so much diluted; which doth plainly shew

shew , that the thinner the Blood is, and the more diluted the Nutritious juice , the less quantity of Spirits is required to subtilize it, and make it capable of passing into the Fibers.

It may easily be observed, that those People whose Spirits are strong , and their *Arterial juice* very thin, are Nimble; but the Contractions of their Muscles are not so durable, as of those, whose Serum is of a thicker Consistence : For tho' in the former more of the Subtile *Liquor* is prepared, yet by Reason of its Tenuity it's sooner receiv'd, and carried off by the *Lymphæducts*; which makes the Contraction shorter,

A Fifth.

Those whose Blood abounds
with fixed Salts &
A Sixth. Phlegmatick Hu-
mours, which too much dull
and resist the Activity of the
Animal Spirits, are always slow
and unapt for Motion; where-
as, if the Blood Acted as a
Pondus, they must be more
nimble and strong; because
the thicker the Blood is the
heavier would be the Pon-
dus.

As Muscular Motion is ma-
ny ways vitiated, by the fault
of the *Arterial juice*, or of the
Spirits, and consequently by
the Distemperature of this sub-
tile *Liquor*; so it is very often
depraved, and accordingly as
the Mass of Blood degenerates
from

from its genuine and proper Nature, are produced various Diseases or Symptoms of Diseases: *viz.* Cramps, Convulsions, Palpitation of the Heart, Leaping of the Tendons in Fevers, &c. for a farther illustration of my Hypothesis, before I conclude, I will give the Reasons of these *Phenomæna*.

When by an Abuse of Non-Naturals, the Elements of the *Viscera* are perverted;

*The Reasons
of Convulsions.*

and by the faults of the Pancreatick juice and of the Spleen, an Acid or Austere Salt is carried forth into a flux; presently the Mass of Blood is vitiated. The Animal Spirits

F 4

meeting

meeting with this vitious Salt, and fermenting in the *Glands*, do there cause irregular Explosions of matter, into the Carnous Fibers, subtilized in that Fermentation; whence follow irregular Contractions of the Muscles.

Why Convulsive Paroxysms come at uncertain times, will easily appear, if we do but consider the Procatartick Causes; amongst which I shall only mention two, *viz.* The Quantity of Morbifick matter irritating Nature to an Expulsion of it; and sudden Passions of the Mind.

The Quantity of Morbifick matter is far greater in some Bodies than in others, before
the

the Spirits are able to recover themselves, and to endeavour an Expulsion of it : In the former Case, Convulsions are Universal and seize the whole Body; in the Latter Particular, the Morbifick matter being accidentally driven more on one Part than another. Again in some Bodies it is sooner heaped up, being generated in greater quantities.

The Matter heaped up, at the first is very crude and thick, and although it be cast forth into, and Circulates through, the Musculous parts, and continually Ferments with the Spirits in the *Glandules* ; yet because it is not sufficiently

F 5 at-

attenuated to be driven forth into the fleshy Fibers, till by frequent Circulations and Fermentations, it is exalted from it's state of fixedness to a more Volatile, no Convulsions succeed. Moreover as long as it continues in its state of Crudity, the Animal Spirits are much dulled and their Activity quashed by mixing with it, but it being at the length subtilized and rarified by frequent Circulations, the Animal Spirits recovering 'em selves, and violently Fermenting with it in the *Glands* carry this Vicious *juice* explosively into the Fibers. The Reason why this Motion is Involuntary, is, because it is not produced by a greater

greater quantity of Spirits flowing from the Brain, accordingly as the Pores are dilated by our Appetite, but by a mixture of Morbifick and Fermentitious Particles, which cause Preternatural Fermentations & Expulsions of Matter Attenuated thereby.

Convulsive fits are sometimes brought on, before the Morbifick matter gradually arrives at this state of tenuity, when upon sudden Passions of the Mind, the Animal Faculties quit their Stations, and being overpowered by external Objects can no longer moderate the Emanations of the Animal Spirits. The Formal Cause of the Irregular Emanations of the Spirits in these Convulsions is this; the
Pores

Pores of the Brain being shut up, to keep out external Objects, heap up the Spirits, till by Reason of their quantity, the Pores can no longer retain them; and then the Spirits rush out *quâ datur portâ* in a greater quantity, and violently setting upon the Crude *juice*, which they meet with in the *Glandules*, strongly Ferment Attenuate and carry it forth into the Fibers, of the Muscles wherein the Spirits are thus accidentally laid down: The Brain being thus emptied, the Pores are shut up again, till the quantity of Spirits make way again; and so successively follow Convulsive Motions, in this or that Part where-ever the Spirits set upon the Crude Morbifick Matter.

The

The Palpitation of the Heart, as the Learned Dr. *Willis* has noted, sometimes proceeds from Convulsive Motion : The Reason why the Morbifick Matter only shews it self in this part, and at the same time in no other parts of the Body is this. The Mass of Blood is impregnated with a Morbifick taint, and whatever is the Nature of it, since it is dispersed through the whole Body, one might Rationally expect Universal Convulsions as well as Particular : But this Morbifick Matter being as yet Crude, and not of a sufficient Quantity to irritate Nature,

Of the Palpitation of the Heart.

Nature in all the Parts of the Body ; these Effects are only produced in this Part , where a large Quantity of Spirits is continually laid down to ferment with it ; by which means it is Subdued in this Part , before it arrives at such a State of Activity or such a Quantity , as to cause irregular Fermentations and Contractions in other Parts.

In a Τένανος, Ἐμπροσδόντος, Ὁπισ-
 δόντος, The Muscles
 Τένανος , continue constantly
 Ἐμπροσδόν- contracted against
 νος, Ὁπισδόν- our Appetite ; these
 τος. Distempers seize
 People, whose Blood is rather
 of a Vitriolick Tenacious Na-
 ture,

ture, and impregnated with more Fermentative Spirits; so that by reason of the Viscidity of the Matter violently forced into the Fibers, either the Lymphæducts are obstructed, or by reason of a continual Fermentation, Matter gradually succeeds.

In the Cramp, the Fermentation is different from that which is *of the Cramp.* Natural, or in other Convulsive Motions; that which is Natural, being caused by the Animal Spirits preparing a Subtil and Homogenous Liquor: In other Convulsions the Animal Spirits ferment with,
and

and endeavour to subdue a Morbifick Humour brought and layed down by the Arteries, and the Matter thus attenuated, is accidentally forced into the Fibers: But these are caused by the continual Conflict of the Volatile Animal Spirits, strongly fermenting with Fermentative and Elastick Particles of another Nature, supplied by the Mass of Blood; where both striving to subdue each other, the Elastick Particles of the Blood, more strongly oppose the Motion of the Spirits, and the Spirits them, by a contrary agitation and intestine Motion of their Particles; and these Two being violently exploded, and impetuously leaping

ing into, and fermenting in the
Fibers, cause most strong and
painful Contractions.

The *Subsultus Tendinum* in
Fevers are caused,
when the Spirits Of the Sub-
sultus Tendi-
num in Fevers.
being too much
exalted, leap irre-
gularly out of the Brain, and
raise the Fermentation in the
Glands so high, as to prepare and
carry too much of the Subtile
Liquor into the Fibers; which
because it is so very thin, easily
slips into the Lymphæducts,
and makes the Contraction
short.

I shall

I shall add the Reason only
 of one other *Phænomenon*, which seems
 more evidently to
 prove, that Muscular Motion
 depends on the greater influx
 of Animal Spirits, *viz.* Why
 the Contraction of one Muscle
 followeth, when the Antagonist
 becomes Paralytick, as in *Spas-*
mus Cynicus: The Branches of
 the Nerves being derived from
 the Brain, when the Influx of
 the Spirits into the Muscles of
 the one side are hindered, they
 regurgitate, and are driven
 presently in a greater quantity
 into the Antagonist; as by
 the Loss of one Eye, the other,
 by a greater Influx of Spirits,
 becomes

becomes more Acute: This is evident, and needs no further proof.

Thus I have laid down my Hypothesis of the Formal and Efficient Causes of Muscular Motion, and how it is vitiated or depraved ; which I the more willingly commit to the Judgment of Learned and Competent Judges, with due Submission ; because it seems to me to answer Natural Ends , and to account for the several *Phænomena* , without the Difficulties , Enormous Motions and Impossibilities , which usually attend Hypotheses on this Subject ; not doubting, but it will

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will give satisfaction, till one
more probable and plausible
shall succeed.

FINIS.



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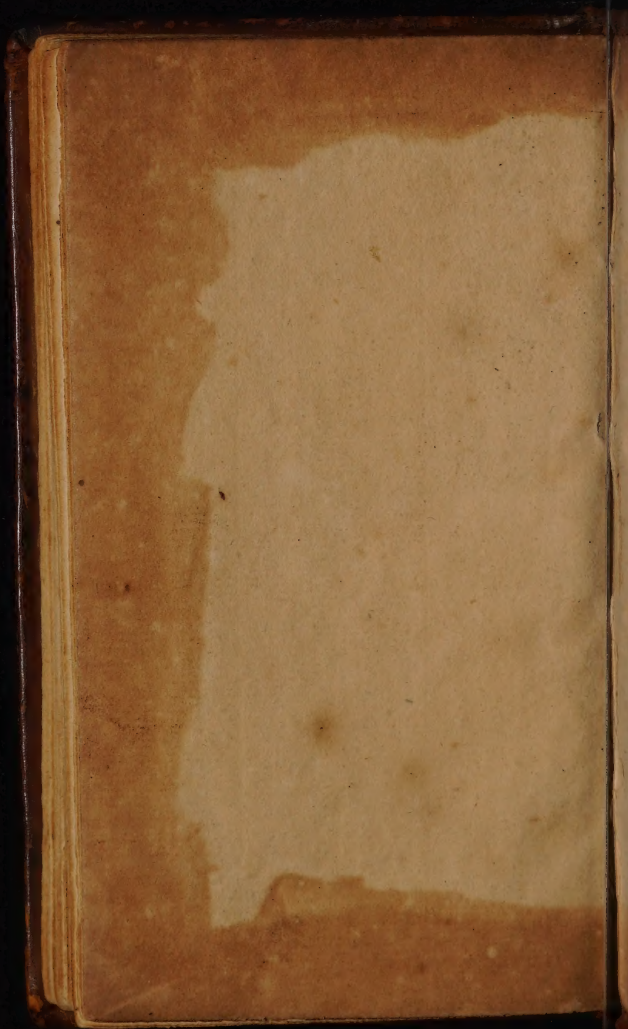
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